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The 1987 Beluga (*Delphinapterus leucas*) Harvest in the Mackenzie River Estuary, NWT

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by

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ABSTRACT

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Information collected by Inuvialuit hunt monitors during the 1987 subsistence beluga (Delphinapterus leucas) fishery in the Mackenzie River estuary, NWT is summarized and discussed; a program assessment is appended. Hunt documentation (struck and landed totals, estimated total kill, loss rates, landed catch composition and distribution) is presented cumulatively and by reporting area. Harvest analysis indicates that in 1987, 174 beluga were struck and 154 were landed. Seventeen percent of the number struck were lost. The total kill is estimated to be at most 188 beluga. Of the total landed catch, 47% were male and 38% were female; more whales were landed in Kugmallit Bay than elsewhere in the estuary. Biological information obtained from the landed catch is presented and discussed. Mean lengths of landed males and females were 431 cm and 376 cm respectively. Seventeen females were documented as reproductively active.

Key words: western Arctic; Beaufort Sea; Monodontidae; harvest analysis; morphometry; reproduction.

RÉSUMÉ

Weaver, P.A. 1991. The 1987 beluga (Delphinapterus leucas) harvest in the Mackenzie River Estuary, NWT. Can. Manuscr. Rep. Fish. Aquat. Sci. 2097: iv + 18 p.

On trouvera un résumé et une discussion des données recueillies par des observateurs inuvialuit sur la pêche de subsistance au béluga (Delphinapterus leucas) dans l'estuaire du fleuve Mackenzie, T. N.-O., en 1987; une évaluation du programme est annexée. Les données sur la chasse (total des animaux atteints par balle et des animaux débarqués, capture totale estimée, taux de pertes, composition et distribution de prises débarquées) sont présentées de manière cumulative pour chacune des zones d'observation. Une analyse de la récolte indique qu'en 1987, 174 bélugas ont été atteints et que 154 ont été débarqués. Dix-sept pour cent des animaux atteints ont été perdus. On estime à 188 au maximum le nombre d'animaux tués. Parmi les prises totales débarquées, on comptait 47 p. 100 de mâles et 38 p. 100 de femelles. On a capturé plus de bélugas dans la baie de Kugmallit qu'ailleurs dans l'estuaire. Les données biologiques obtenues à partir des prises débarquées sont présentées et discutées. La longueur moyenne des bélugas mâles et femelles débarqués était de 431 et 376 cm respectivement. Dix-sept femelles ont été décrites comme reproductivement actives.

Mots-clés: ouest de l'Arctique; mer de Beaufort; monodontidés; analyse de la récolte; morphométrie; reproduction.

INTRODUCTION

The Beaufort Sea beluga (Delphinapterus leucas) stock is considered one of four provisional stocks which comprise the Bering Sea population (Seaman et al 1986). Belugas comprising this management stock migrate in the spring from their wintering grounds in the Bering Sea to the southeastern Beaufort Sea (Fraker 1980). An estimated 7 000 beluga occupy the onshore waters of the Mackenzie River estuary during the summer months (Norton and Harwood 1985). These animals are likely geographically isolated from eastern arctic beluga stocks by the boundary of the permanent pack ice and by landforms associated with the Coronation and Queen Maud Gulfs (Sergeant and Brodie 1969, 1975). This premise is supported by harvest statistics compiled by the Department of Fisheries and Oceans (DFO) (Strong 1989), which suggest that mixing does not occur through the southern route. In the Mackenzie estuary beluga localize in discrete 'concentration areas' (Fraker 1980), where they are hunted by residents of Aklavik, Inuvik and Tuktoyaktuk. This subsistence harvest is not subject to quota and is conducted mainly during July and August, although occasionally whales are landed in late June and early September. Hunting is restricted to original peoples and to non-natives possessing a license issued by the Department of Fisheries and Oceans.

Strong (1989) summarized the annual landed harvest totals of beluga in the Mackenzie estuary from 1954 - 1987. Biological monitoring of the stock was sporadic until 1973 (Radvanyi 1959, Sergeant and Hoek 1974). Hunt (1979) reported on the biological information and landed harvest totals collected from 1973 - 1975 in the Mackenzie estuary. A suite of industry-funded harvest and biological monitoring programs began in 1973 and continued annually until 1983 (Fraker 1977, 1978; Fraker and Fraker 1979, 1981, 1982; Fraker 1983; Slaney 1973, 1974, 1975, 1976, 1977). From 1981-1986 DFO (Central and Arctic Region) conducted a beluga harvest monitoring and biological collection program in the area (Strong 1990).

In 1986, the Fisheries Joint Management Committee (FJMC) was established pursuant to Section 14(61) of the Inuvialuit Final Agreement. This agency has the legislative requirement to report current fish and marine mammal harvest levels within the Inuvialuit Settlement Region. In 1987 the FJMC assumed responsibility for monitoring the beluga whale harvest in the Mackenzie estuary; however the program was implemented jointly with DFO during its transition year. The continuing objectives of this program are to produce reliable annual harvest statistics and biological information from the landed catch. This report summarizes the harvest statistics and biological information obtained during the 1987 beluga harvest in the Mackenzie Estuary, NWT.

STUDY AREA

The study area encompasses the Mackenzie River estuary at the Beaufort Sea coast, in the western Canadian arctic (Fig. 1). The Mackenzie River flows into the Beaufort at approximately $69^{o}N$ $135^{o}W$, draining an area of 1.787 million km^2 (Rosenberg and Barton 1986). Its estuary lies within the 5 m depth contour with average onshore depths of 2-3 m over a substrate of sand, soft-mud and gravel (Hunter 1975).

Richards Island forms a northward extension of the delta, around which the beluga concentration areas (Fraker 1980) at Niakunak Bay, Kendall Island and Kugmallit Bay are located. These concentration areas are the focus of the annual subsistence beluga harvest and several traditional hunting camps are located along the coast adjacent to them. Information on the beluga harvest is collected from an area bounded on the west by Shingle Point, to the north by Gary, Pelly and Hooper Islands, and on the east by the hamlet of Tuktoyaktuk (Fig. 1).

MATERIALS AND METHODS

This study employed the methods of on-site data collection developed by DFO from 1981-1986 (Strong 1990). The Hunters and Trappers Committee (HTC) in each of the three beluga hunting communities recommended individuals for the position of hunt monitor. Two Inuvialuit hunters from each community, in most cases summer residents of one of the traditional whaling camps, were hired on short-term contract to observe the beluga harvest and to collect biological and hunt information from landed whales. Hunt monitors were interviewed individually at the start of the season to review the contract requirements; each received an illustrated instruction manual and all the equipment necessary for data and sample collection. They documented beluga hunting activity between the first week of July and mid-August and as deliverables returned: prepared data forms summarizing the summer's hunting activity and biological information collected from landed whales (Appendix 1); a field diary containing daily summaries of weather, hunting activity, and aerial or industrial activity of potential effect to the harvest; ageing material collected from landed whales and a final report documenting their impressions of the annual harvest.

The hunt monitors documented hunting events by on-site hunter interview. Information related to individual hunts included weather and water conditions, the number of hunters and their home community, the hunt duration, the rifle calibre(s) used, the number of shots fired and the number required to kill each whale, and the number of whales struck and landed.

Biological information collected from landed whales included sex, colour category, reproductive status of females, ageing material and the following measurements (Norris 1961) in Imperial units: standard length, axillary girth, fluke width, and flipper length and width.

Program managers visited each camp at least once to review data sheets and collect samples from the hunt monitors, and to discuss the hunt and answer questions from local hunters. These visits sometimes coincided with coastal helicopter patrols during which we counted, and when possible measured and sampled "stinkers" (whales killed and lost which later wash up onshore).

Strong (1990) classed data records into four areas corresponding to the beluga concentration areas. Following this format for ease of comparison, the hunting areas (and the camps located within them in 1987) were: Tuktoyaktuk (includes Hendrickson Island, the Hamlet of Tuktoyaktuk and outlying camps), East Whitefish Station (includes East Whitefish, Indian Camp, Kittigazuit, and Swimming Point), Kendall Island (includes Kendall, Baby, Garry and Pelly Islands) and West Whitefish Station (includes Bird's Camp, West Whitefish, Jason Creek, Running River and Shingle Point).

Prior to analysis, Imperial measures were converted to metric and rounded to the nearest centimeter. The record sheets and field diary submitted by each hunt monitor were cross-referenced to complete the record of hunting activity. The hunt monitors usually do not make interpretive decisions about mortal and superficial wounding because they do not observe all hunts (beluga in this region are typically hunted individually rather than by drives). To partly compensate for the uncertainty associated with wound severity sustained by animals reported struck and lost, loss rates are reported as a proportion of the number of animals struck (Weaver and Walker 1988) using the formula:

$$\frac{\text{Total \# Struck} - \text{Total \# Landed}}{\text{Total \# Struck}}$$

All beluga reported as struck but not landed are assumed to have been sunk. Although this assumption inflates reported losses slightly it is preferable to the alternative, that is to underestimate sinking losses.

The 1987 beluga harvest data is stored on the Freshwater Institute Micro Vax II computer. It was analysed using SAS (1985) procedures with the critical level for hypothesis testing set at 0.05.

RESULTS AND DISCUSSION

HUNT DOCUMENTATION

The landed catch

The hunt monitors collected information between 01 July and 15 August 1987, during which time they documented 154 beluga struck and 134 landed. The Tuktoyaktuk monitors estimated that 10 whales were landed but not examined, and that an additional 10 whales were sunk but not reported to them by the hunters. This information increased the best estimate of total hunting activity to 174 beluga struck and 144 landed (Table 1).

Hunting pressure from Tuktoyaktuk has consistently exceeded that of the other areas in the estuary, and in 1987 56% of the total landed catch was harvested in this reporting area (Table 2). Hunters from the East Whitefish, Kendall Island and West Whitefish areas accounted for 22%, 9% and 13% of the total landed catch respectively. Beluga from the Kugmallit Bay concentration area, harvested in the Tuktoyaktuk and East Whitefish reporting areas, dominate the landed catch. From 1980-1987 Kugmallit Bay removals have generally increased from 53% in 1980 to 78% of the total landed catch in 1987 (Table 2).

Of the best-estimated landed catch of 144 beluga, 68 (47%) were male, 54 (38%) were female and 22 (15%) were of unknown gender. The 10 undocumented whales estimated landed in the Tuktoyaktuk reporting area are included as unknowns (Table 3). Although experienced hunters claim the ability to do so, the sex of an unaccompanied beluga can be difficult to determine. Beluga hunters in the Mackenzie estuary appear to select larger animals, likely to maximize the return for their hunting effort (see Morphometrics section). This is reflected in the composition of past harvests; male beluga have comprised an average of 57% of the landed catch since 1980 (Table 4).

The hunting community and DFO generally discourage the pursuit of females, however the proportion of females in the landed catch has averaged 31% since 1980 (Table 4). In 1987 the proportion of females in the best estimated landed catch was 38%, less than that documented in 1986 (43%) but higher than any other year since 1981. The largest number of females has been harvested in the Tuktoyaktuk reporting area in all years but two since 1980. In 1987, 32 (59%) females were landed in the Tuktoyaktuk reporting area, ten (19%) in the East Whitefish reporting area, four (7%) in the Kendall Island reporting area and seven (13%) in the West Whitefish reporting area (Table 5).

Loss rates

In 1987 17% of all beluga struck in the Mackenzie Estuary were lost (Table 6). This value is within the range of previously reported losses (Strong 1990) which, excepting 1984, increased steadily from 1980-1986. The 1987 harvest was more efficient than that reported for 1986; a similar number of beluga were landed with considerably fewer strikes (Table 6). While 1987 losses are less than those reported in 1985 and 1986, to suggest they represent a declining trend is premature.

Of the individual hunting areas, the highest loss (24%) occurred at West Whitefish Station; loss rates of 20%, 9% and 7% occurred in the Tuktoyaktuk, East Whitefish Station and Kendall Island areas respectively. Losses in all areas are less than those incurred in 1986; the reduction being considerable in the East Whitefish and Kendall Island reporting areas (Table 2).

Loss rates vary with hunter experience, hunting technique and the completeness of the hunting record. Hunt (1979) and Fraker (1980) discuss other factors affecting loss rates such as hunter attitude, inadequate or improper ammunition and gear, available whale numbers and their behaviour, and sudden changes in weather. Some or all of these factors remain applicable in some degree in each of the reporting areas.

Previously estimated losses are reported in terms of the landed catch. Lowry et al (1989) estimate loss rates of 40% during individual or group hunts for beluga in Alaska, but it is not clear whether this value is based on the number of whales struck or the number landed. In the Mackenzie Estuary, Hunt (1979) estimated hunting losses at 40% of the landed catch during the 1973-1975 harvests; Fraker (1980) suggested a loss rate of about 30% of the landed catch for harvests in the late seventies. Strong (1990) reports that loss rates for 1980-84 were less than 20% of the landed catch and that they rose dramatically in 1985 and 1986 (24% and 38% of the landed catch, respectively); possible reasons for this increase are not offered. By comparison, the 1987 losses amounted to 21% of the landed catch.

Estimated total kill

Hunting mortality is either direct (when an animal is struck by a bullet) or indirect (when pregnant or lactating females are harvested). Refined estimates of direct hunting loss are possible when hunt documentation classifies wounding as mortal or superficial (Finley and Miller 1982, Weaver and Walker 1988). Indirect losses will remain difficult to assess until more information on survivorship is available. While it is reasonable to assume that all abandoned neonates will die, this assumption is likely not true for abandoned yearlings, especially if separation occurs later in the year.

For the 1987 harvest, direct hunting losses are estimated by assuming that all beluga reported struck and lost were sunk, because documentation lacks information on sinking losses and wound severity (see Methods). Indirect hunting losses are estimated by assuming the death of calves attending nursing females, because calves are not described as neonates or yearlings. These assumptions slightly inflate the estimated total kill but in the absence of more detailed hunt documentation, a conservative approach is applied.

In 1987 the hunt monitors documented 154 strikes and submitted a best estimate of 174. Fourteen lactating females were documented, accompanying calves were reported with nine of them. The estimated total kill by Canadian hunters is at least 168 and is best estimated as 188 beluga; the larger value represents 2.7% of about 7 000 animals thought to occur in the onshore waters of the Mackenzie estuary (Norton and Harwood 1985).

BIOLOGICAL INFORMATION

Morphometrics

Hunt monitors documented 54 female and 68 male post-natal beluga in 1987; morphometric measurements are available for most of these animals. Incomplete records were submitted when hunt monitors examined partly flensed animals. Frequency histograms of standard length for the pooled and individual reporting area harvests appear in Figures 2 to 4. All landed beluga were longer than 300 cm, except one landed male (262 cm) which is considered an outlier and excluded from subsequent analysis.

Descriptive statistics for the pooled 1987 sample appears in Table 7. Mean morphometric measurements collected from males are all significantly larger ($p<0.05$) than those collected from females. The mean standard length of 56 harvested males was 431 cm (range 361-498 cm), that of 36 females was 376 cm (range 335-443 cm). Mean standard lengths of male and female beluga landed in northwest Alaska were 403 cm and 351 cm, respectively (Burns and Seaman 1986). Although beluga landed in the Mackenzie estuary are somewhat larger, this may simply reflect different hunting techniques and seasonal pod composition (Burns and Seaman 1986).

Reproduction

Monitors provided information about the reproductive condition of 30 (56%) of the landed females. Of these 17 were either pregnant (3 animals), lactating only (5 animals), lactating

and/or accompanied by a calf (9 animals) (Table 8). The proportion of reproductive females in the subsample of females for which information exists is 0.56. This proportion is applied to the number of females in the landed catch (to estimate the number of reproductively active females harvested in 1987). By this method an estimated 31 of the 54 females landed may be have been reproductively active.

The mean standard length of 15 reproductively active females examined in 1987 was 374 cm (range 335-443 cm); comparable to values reported by Strong (1990) (mean 364 cm, range 320-457 cm) for reproductively active females landed from 1981-1986 in the Mackenzie estuary. Burns and Seaman (1986) indicate that 90% and 100% of the light grey and white females examined in northwest Alaska were sexually mature. Standard lengths of these animals are not tabulated; however data from 11 light grey and 35 white females measured produced means of 330 cm (range 305-361 cm) and 351 cm (312-373 cm) respectively.

Lengths of two fetuses measured in 1987 are consistent with those previously reported from this population. Burns and Seaman (1986) calculated a mean length of 155 cm for near term fetuses collected in June in Alaska. Strong (1990) reported mean lengths of 19 cm and 159 cm for non-term and near-term fetuses respectively. In 1987 standard lengths of one near term fetus and one first trimester fetus measured in mid-July were 155 cm and 21 cm respectively. There is no information about the fetus carried by the third pregnant female.

PROGRAM ASSESSMENT

This program benefits both researchers and resource users. It contributes reliably complete documentation of hunting pressure sustained by the Beaufort beluga stock over most of its summer range. The information contributed by this program is collected on-site, from hunters by hunters. Consequently, the problem of recall bias is considerably reduced, and that of non-response is largely avoided. Data are collected concurrently across the study area; as such they are likely more complete than could be collected otherwise. Lastly, the program provides a method by which resource users can participate in the management of their animal resources, and acquire basic skills and experience in data collection and sampling.

The program provides data of reliable quality; the biases affecting it are common to all field programs employing multiple observers. Some within- and between-year variation is introduced when data is collected by persons other than the designated hunt monitor (owing to absence or number of whales to be examined), changeing hunt monitors between years, the increased experience acquired by regular hunt monitors and the degree of hunter cooperation in reporting their catch. Hunter cooperation has the greatest potential to affect harvest data quality. Any existing effect on this program is lessened by the hunt monitors' assessments of undocumented hunting activity.

The program's contribution would be enhanced in future by documenting rates of mortal versus superficial wounding for beluga struck but not landed, and by improving the response rate of the hunt monitors to questions about landed females. In some reporting areas, an undefined proportion of the harvest remains undocumented. Local HTC's should encourage the continued cooperation of hunters in reporting their activity to the hunt monitors, thereby reducing the error inherent in estimating unreported landings and sinking losses.

SUMMARY AND CONCLUSIONS

1. Hunt monitors documented 154 beluga struck and 134 landed between 01 July and 15 August 1987 in the Mackenzie River Estuary. When observers' estimates of beluga struck and landed but not reported are included,the harvest is best estimated at 174 beluga struck and 154 landed.

2. Hunters in the Tuktoyaktuk reporting area landed 56% of the total harvest. Hunters in the East Whitefish, West Whitefish and Kendall Island reporting areas landed 22%, 13% and 9% of the total respectively. Hunting pressure remains greatest in Kugmallit Bay, beluga from this concentration area comprised 78% of the landed catch in 1987.

3. Of the best estimated landed catch of 144 beluga, 68 (47%) were male, 54 (38%) were female and 22 (15%) were of unknown gender. The proportion of females harvested in 1987 is less than that documented in 1986, but greater than any other year since 1981. More females were landed in the Tuktoyaktuk reporting area than elsewhere in the estuary. Local HTC's should encourage a reduction in the number of females harvested by their members.

4. Loss rates are presented in terms of the total number of strikes, to compensate for the lack of information on mortal and superficial wounding. All beluga reported struck but not landed are assumed to have been sunk. In 1987 17% of all beluga struck were lost. Hunt monitors in the Tuktoyaktuk, East Whitefish, Kendall Island and West Whitefish reporting areas documented losses of 20%, 9%, 7% and 24%

respectively. The pooled and individual reporting area losses are less than those documented in 1986.

5. Total kill is conservatively estimated by combining the best estimates of beluga struck with the estimated number of calves lost in association with landed females. Since 14 nursing females were among the landed catch, the total kill is best estimated as 188 beluga. Total kill by Canadian hunters represents 2.7% of the accepted onshore component of the Beaufort beluga stock.

6. To allow more accurate estimation of removal rates, hunt monitors should begin to collect information about sinkage and wound severity sustained by target beluga (i.e. mortal versus superficial). Local HTAs should encourage the continued cooperation of their members in reporting their catch to the hunt monitors.

7. Hunt monitors measured 54 female and 68 male post-natal beluga in 1987. The mean standard length of males was 431 cm (range 361-498 cm), that of females was 376 cm (range 335-443 cm).

8. The mean standard length of 15 reproductively active females landed in 1987 was 374 cm (range 335- 443 cm). By ratio comparison, an estimated 31 of the 54 female beluga landed in 1987 were reproductively active. Hunt monitors provided information about the reproductive condition of 30/54 landed females (56%). Program managers should encourage more complete documentation of landed females and calves associated with them.

9. The hunt monitoring program provides reliable information about subsistence use of beluga in the Mackenzie River estuary. It's contribution would be enhanced by documenting wound severity and by improving the response rate to questions about landed females. The continued cooperation of beluga hunters in reporting their harvests is encouraged.

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REFERENCES

BURNS, J.J., and G.A. SEAMAN. 1986. Investigations of beluga whales in coastal waters of western and northern Alaska. II. Biology and ecology. Final Rep. NOAA, Outer Continental Shelf Environmental Assessment Program Contract NA-81-RAC-00049. Alaska Department of Fish and Game, Fairbanks. 60 p.

DAVIS, R.A., and C.R. EVANS. 1982 Offshore distribution and numbers of white whales in the eastern Beaufort Sea and Amundsen Gulf, summer 1981. Unpubl. Rep. by LGL Ltd. for SOHIO Alaska Petroleum Co., Anchorage, AK and Dome Petroleum Ltd., Calgary, Alberta. 76 p.

FINELY, K.J. and G.W. MILLER. 1982. The 1979 hunt for narwhals (Monodon monoceros) and an examination of harpoon gun technology near Pond Inlet, northern Baffin Island. Rep. Int. Whal. Commn. 32: 449-460.

FRAKER, M.A. 1977. The 1977 whale monitoring program, Mackenzie Estuary, N.W.T. Prepared for Imperial Oil Limited, Calgary, by F.F. Slaney & Company Limited, Vancouver, Canada. v + 53 p.

FRAKER, M.A. 1978. The 1978 Whale monitoring program, Mackenzie Estuary, N.W.T. Prepared for Imperial Oil Limited, Calgary, by F.F. Slaney & Company Limited, Vancouver, Canada.

FRAKER, M.A. and P.N. FRAKER. 1979. The 1979 whale monitoring program, Mackenzie Estuary. Unpublished report by LGL Limited for Esso Resources Canada Limited, Calgary. 51 p.

FRAKER, M.A. 1980 Status and harvest of the Mackenzie stock of white whales (Delphinapterus leucas). Rep. Int. Whal. Commn. 30: 451-458.

FRAKER, P.N. and M.A. FRAKER. 1981. The 1980 Whale monitoring program, Mackenzie Estuary. Unpublished report by LGL Limited

for Esso Resources Canada Limited, Calgary, Canada. 98 p.

FRAKER, P.N. and M.A. FRAKER. 1982. The 1981 white whale monitoring program, Mackenzie Estuary. Unpublished report by LGL Limited for Esso Resources Canada Ltd., Dome Petroleum Limited and Gulf Canada Resources Inc., Calgary, Alberta. 74 p.

FRAKER, P.N. 1983. The 1982 white whale monitoring program, Mackenzie Estuary. Part I. Migration, distribution and abundance of whales and effects of industry activities on whales. Unpublished report by LGL Limited for Esso Resources Canada Ltd., Dome Petroleum Ltd. and Gulf Canada Resources Inc., Calgary. 54 p.

HUNT, W.J. 1979. Domestic whaling in the Mackenzie estuary, Northwest Territories. Can. Fish. Mar. Serv. Tech. Rep. 769: iv + 14 p.

HUNTER, J.G. 1975. Fishery resources of the western Arctic. Fish. Res. Board Can. Biol. Manuscr. Rep. 1335: 25 p.

LOWRY, L.F., J.J. BURNS, and K.J. FROST. 1989. Recent harvest of belukha whales (Delphinapterus leucas), in western and northern Alaska and their potential impact on provisional management stocks. Rep. Int. Whal. Commn. 39: 335-339.

NORRIS, K.S. 1961. Committee on marine mammals standardized methods for measuring and recording data on the smaller cetaceans. J. Mammal. 42: 471-476.

NORTON, P.N., and L.A. HARWOOD. 1985. White whale use of the southeastern Beaufort Sea, July-September 1984. Can. Tech. Rep. Fish. Aquat. Sci. 1401: v + 46 p.

RADVANYI, A. 1959. Preliminary report on the 1959 whaling operation in the Beaufort Sea area. Canadian Wildlife Service manuscript. 10 p.

ROSENBERG, D.M., and D.R. BARTON. 1986. Environmental features of the Mackenzie system. pp. 435-471. In B.R. Davies and K.F. Walker (ed.) The ecology of river systems. W. Junk, Dordrecht.

SAS INSTITUTE INC. 1985. SAS Users Guide: Basics, Version 5 Edition. Cary, NC. 1290 p.

SEAMAN, G.A., K.J. FROST, and L.F. LOWRY. 1986. Investigations of beluga whales in waters of western and northern Alaska. I. Distribution, abundance, and movements. Final Rep. NOAA, Outer Continental Shelf Environmental Assessment Program Contract NA-81-RAC-00049. Alaska Department Fish and Game, Fairbanks. 60 p.

SERGEANT, D.E., and P.F. BRODIE. 1975. Identity, abundance and present status of populations of white whales, Delphinapterus leucas, in North America. J. Fish. Res. Board Can. 32: 1047-1054.

SERGEANT, D.E., and P.F. BRODIE. 1969b. Body size in white whales, Delphinapterus leucas. J. Fish. Res. Board Can. 26: 2561-2580.

SERGEANT, D.E., and W. HOEK. 1974. Seasonal distribution of bowhead and white whales in the eastern Beaufort Sea. p. 705-719. In Reed, J.C. and J.E. Sater (ed.). The coast and shelf of the Beaufort Sea. Arctic Institute of North America. 750 p.

SLANEY, F.F. & Company Limited. 1973. Environmental Impact Assessment, Immerk Artificial Island Construction, Mackenzie Bay, N.W.T. Report prepared for Imperial Oil Limited, Calagary, Alberta, Canada, by F.F. Slaney & Company Limited, Vancouver, Canada. 59 p.

SLANEY, F.F. & Company Limited. 1974. White-whale study, Herschel Island - Cape Dalhousie, coastal region of the Beaufort Sea. Report prepared for Imperial Oil Limited, Calgary, Alberta, Canada, by F.F. Slaney & Company Limited, Vancouver, Canada. 29 p.

SLANEY, F.F. & Company Limited. 1975. Summer environmental program, Mackenzie River Estuary, Volume 3, white whale studies. Report prepared for Imperial Oil Limited, Calgary, Alberta, Canada, by F.F. Slaney & Company, Vancouver, Canada. 53 p.

SLANEY, F.F. & Company Limited. 1976. 1975 summer environmental program, Mackenzie River Estuary, Volume 2, White Whale Studies. Prepared for Imperial Oil Limited, Calgary, Alberta, Canada, by F.F. Slaney & Company Limited, Vancouver, Canada. 62 p.

SLANEY, F.F. & Company Limited. 1977. The 1976 white whale monitoring program, Mackenzie Estuary, N.W.T. Report prepared for Imperial Oil Limited, Calgary, Alberta. 73 p.

STRONG, J.T. 1989. Reported harvests of narwhal, beluga and walrus in the Northwest Territories, 1948-1987. Can. Data Rep. Fish. Aquat. Sci. 734: iv + 14 p.

STRONG, J.T. 1990. The domestic beluga (Delphinapterus leucas) fishery in the Mackenzie River estuary, Northwest

Territories, 1981-1986. Can. Data Rep. Fish. Aquat. Sci. 800: iv + 53 p.

WEAVER, P.A., and R.S. WALKER. 1988. The narwhal (Monodon monoceros) harvest in Pond Inlet, Northwest Territories: hunt documentation and biological sampling, 1982-1983. Can. Manuscr. Rep. Fish. Aquat. Sci.1975: iv + 26 p.

Table 1. Harvest analysis, cumulatively and by reporting area, of the 1987 subsistence beluga (*Delphinapterus leucas*) harvest in the Mackenzie Estuary, NWT.

Area	Total Struck	Total Landed	Lost (%)[1]
Tuktoyaktuk: Documented	81	71	10 (12)
: Best Estimate[2]	101	81	20 (20)
East Whitefish Area	34	31	3 (9)
Kendall Island Area	14	13	1 (7)
West Whitefish Area	25	19	6 (24)
Total: Documented	154	134	20 (13)
: Best Estimate[2]	174	144	30 (17)

[1] Calculated using the formula: $\frac{\text{Total Struck - Total Landed}}{\text{Total Struck}}$

[2] The Tuktoyaktuk monitors were most confident in estimating that an additional 10 whales were landed but not examined, and that a further 10 whales were sunk but not reported to them by the hunters.

Table 2. Distribution by reporting area of the landed catch of beluga (Delphinapterus leucas) in the Mackenzie River estuary, NWT, 1980-1987.

Year[1]	Total Harvest	Tuktoyaktuk No. (%)	E. Whitefish No. (%)	Kendall Isl. No. (%)	W. Whitefish No. (%)
1980	73	26 (36)	13 (18)	21 (29)	13 (18)
1981	152	62 (41)	27 (18)	23 (15)	40 (26)
1982	107	39 (36)	23 (22)	25 (23)	20 (19)
1983	86	35 (41)	13 (15)	25 (29)	13 (15)
1984	141	59 (42)	32 (23)	30 (21)	20 (14)
1985	117	59 (51)	21 (18)	25 (21)	12 (10)
1986	151	89 (59)	25 (19)	15 (11)	22 (17)
1987	144	81 (56)	31 (22)	13 (09)	19 (13)

[1] Historical values from Strong (1990).

[2] Total harvest includes 6 beluga caught in nets.

Table 3. Catch composition, by reporting area, of the 1987 beluga (Delphinapterus leucas) harvest in the Mackenzie River estuary, NWT.

Area	Total Landed	Male	Female	Unknown
Tuktoyaktuk	81[1]	29	32	20
East Whitefish	31	21	10	0
Kendall Island	13	9	4	0
West Whitefish	19	9	8	2
Total	144[1]	68 (47%)	54 (38%)	22 (15%)

[1]Best Estimate

Table 4. Percent frequency of each gender in the recorded landed catch of beluga (Delphinapterus leucas) in the Mackenzie River Estuary, NWT, from 1980-1987.

	Male		Female		Unknown	
Year[1]	No.	%	No.	%	No.	%
1980	34	47	36	49	3	4
1981	56	37	57	37	39	26
1982	71	66	27	25	9	8
1983	67	78	16	19	3	3
1984	94	67	17	12	30	21
1985	75	64	26	22	16	14
1986[2]	64	49	57	43	10	8
1987[2]	68	48	54	37	12	15

[1] Historical values from Strong (1990).

2 This study.

Table 5. Composition of the recorded landed catch of beluga (Delphinapterus leucas) in the Mackenzie Estuary, NWT 1980-1987.

		Tuktoyaktuk			E. Whitefish			Kendall Isl.			W. Whitefish		
Year[1]	Total Harvest	M	F	U	M	F	U	M	F	U	M	F	U
1980	73	10	13	3	2	11	0	14	7	0	8	5	0
1981	152	28	17	7	9	18	0	6	15	2	13	7	0
1982	107	14	21	4	22	0	1	22	3	0	13	3	4
1983	86	25	8	2	11	1	1	23	2	0	8	5	0
1984	141	35	5	9	24	5	3	21	6	3	14	1	5
1985	117	27	17	5	17	4	0	23	2	0	8	3	1
1986[2]	131	30	38	1	19	6	0	8	6	1	7	7	8
1987[3]	144	29	32	20	21	10	0	9	4	0	9	8	2

[1] Historical values from Strong (1990)

[2] Total harvest includes 6 beluga caught in nets.

[3] This study.

Table 6. Harvest analysis for past subsistence harvests of beluga (Delphinapterus leucas) in the Mackenzie River estuary, NWT, 1980-1987. Loss rates are expressed in terms of number of whales struck.

Year[1]	Total			Tuktoyaktuk			E. Whitefish			Kendall Isl			W. Whitefish		
	Str	Lnd	Lost(%)	Str	Lnd	Lost(%)	Str	Lnd	Lost(%)	Str	Lnd	Lost(%)	Str	Lnd	Lost(%)
1980	84	73	11 (13)	26	26	0 (0)	15	13	2 (13)	21	21	0 (0)	22	13	9 (41)
1981	177	152	25 (14)	76	62	14 (18)	35	27	8 (23)	25	23	2 (8)	41	40	1 (2)
1982	127	107	20 (16)	44	39	5 (11)	27	23	4 (15)	28	25	3 (11)	23	20	8 (29)
1983	102	86	16 (16)	43	35	8 (19)	15	13	2 (13)	28	25	3 (11)	16	13	3 (19)
1984	156	141	15 (10)	67	59	8 (12)	37	32	5 (13)	31	30	1 (3)	21	20	1 (5)
1985[2]	145	117	28 (19)	67	59	8 (12)	28	21	7 (25)	35	25	10 (29)	15	12	3 (20)
1986[3]	200	145	55 (28)	117	89	28 (24)	35	25	10 (29)	26	15	11 (42)	22	16	6 (27)
1987	174	144	30 (17)	101	81	20 (20)	34	31	3 (9)	14	13	1 (7)	25	19	6 (24)

1 Historical values from Strong (1990).

2 The documented catch was 160 beluga struck and 131 landed (6 of these were netted and are not included in the landed total). The tabulated values reflect the Tuktoyaktuk monitors' estimates of 20 beluga struck but not landed and 20 beluga landed but not documented (Strong 1990).

3 The documented catch was 154 beluga struck and 134 landed. Numbers used to calculate losses reflect the hunt monitors' estimates of the number of beluga struck and landed without documentation.

Table 7. Descriptive statistics for measurements (cm) collected from beluga (Delphinapterus leucas) landed in the Mackenzie River estuary, NWT in 1987.

Measurement	Sex	N	Mean	Mean Std. Error	Standard Deviation	Range
Standard Length	M	56	430.73	4.06	30.39	361 - 498
	F	36	376.00	4.21	25.23	335 - 443
Axillary Girth	M	55	269.04	5.38	39.89	178 - 372
	F	35	229.91	4.22	24.98	193 - 301
Fluke Width	M	52	101.90	1.28	9.24	75 - 122
	F	34	84.50	1.66	9.68	69 - 107
Flipper Length	M	52	45.23	0.71	5.09	36 - 71
	F	34	39.00	0.71	4.13	32 - 48
Flipper Width	M	52	33.12	0.39	2.80	27 - 38
	F	34	27.15	0.55	3.18	20 - 34

Table 8. Information collected by hunt monitors related to the reproductive condition of female beluga (Delphinapterus leucas) harvested in the Mackenzie River Estuary, NWT in 1987.[1]

Date	Specimen	Standard Length[2]	With a Calf	Lactating	Pregnant	Fetus Length[2]
09 July	WWDL8708	386	No	Yes	.	.
04 July	WWDL8712	.	.	Yes	.	.
30 July	WWDL8716	368	Yes	.	.	.
07 July	KIDL8702	376	Yes	Yes	No	.
09 July	KIDL8704	366	Yes	Yes	.	.
20 July	EWDL8720	361	.	Yes	.	.
16 July	TKDL8719	.	.	Yes	Yes	155
03 August	TKDL8725	356	Yes	Yes	.	.
08 August	TKDL8726	371	Yes	Yes	.	.
08 July	TKDL8733	443	.	.	Yes	.
15 July	TKDL8743	387	Yes	Yes	.	.
15 July	TKDL8745	377	No	.	Yes	21
15 July	TKDL8748	353	.	Yes	.	.
22 July	TKDL8755	391	.	Yes	.	.
22 July	TKDL8757	368	Yes	Yes	.	.
05 August	TKDL8773	335	Yes	Yes	.	.
05 August	TKDL8774	373	Yes	Yes	.	.

1 '.' indicates no response.

2 Lengths recorded in cm.

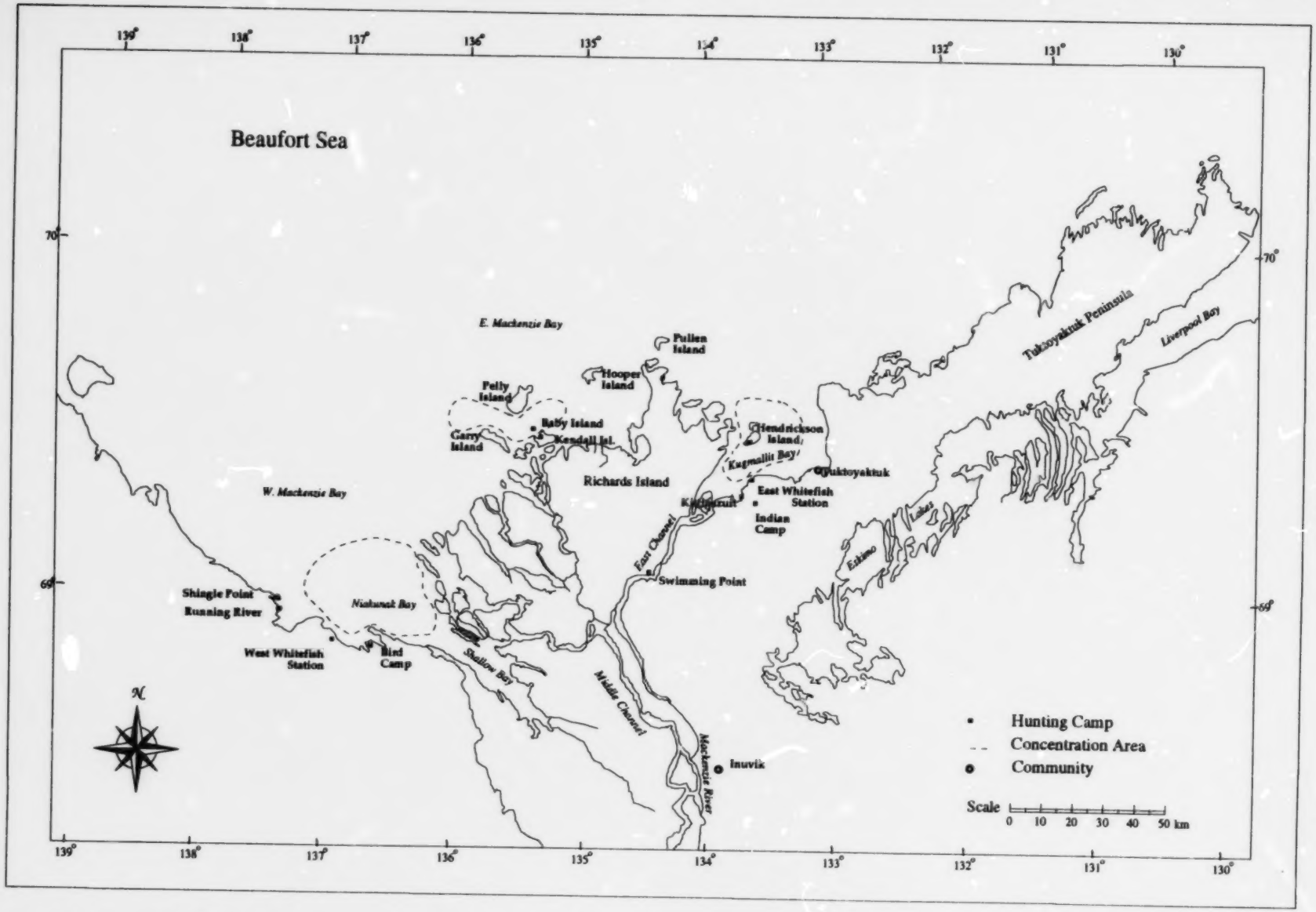

Fig. 1. The Mackenzie River estuary, showing traditional beluga hunting camps and the approximate boundaries of the three beluga "concentration areas" (after Fraker 1980).

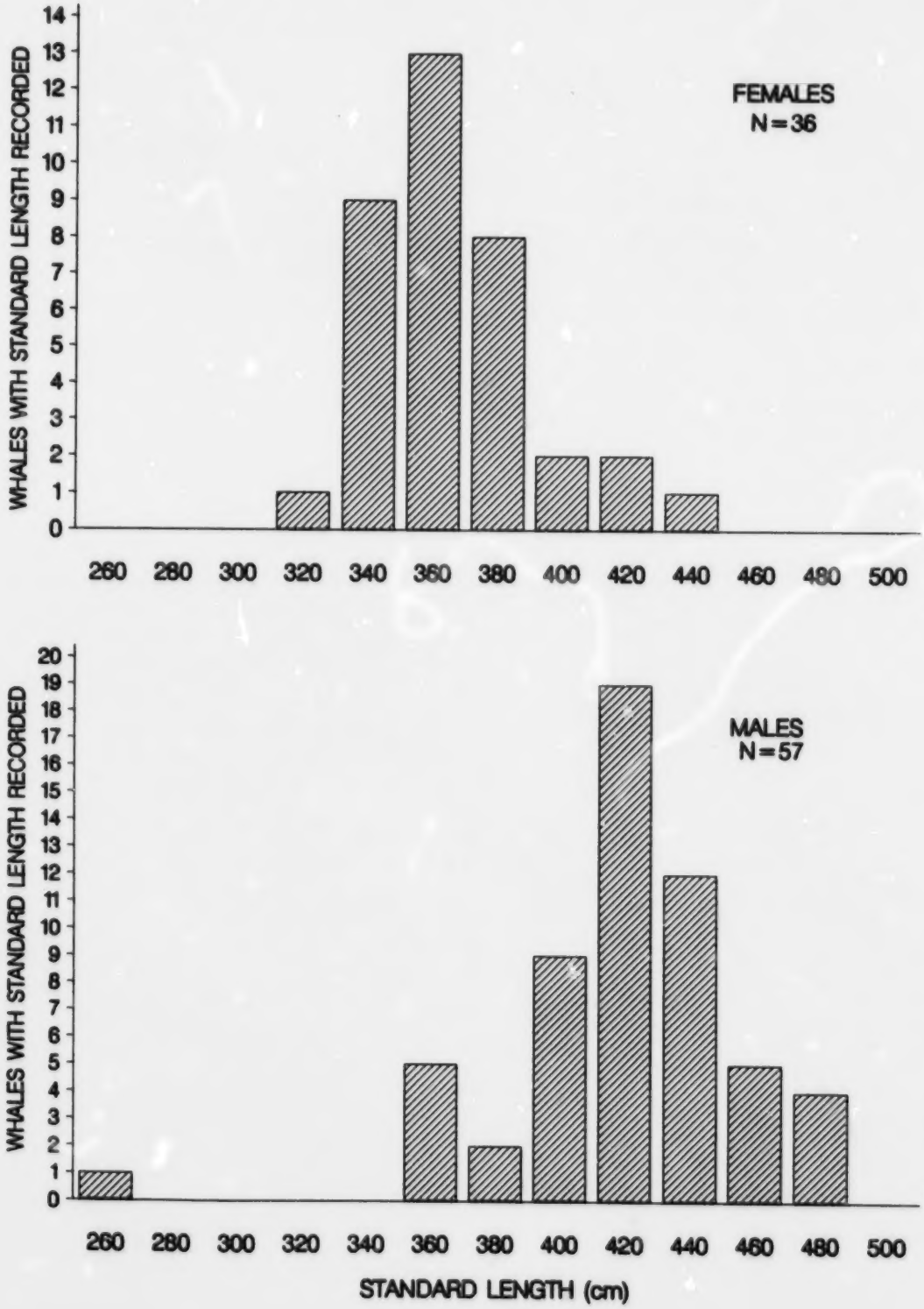

Fig. 2. Length frequency of the pooled landed catch of beluga (Delphinapterus leucas) harvested in the Mackenzie River estuary, NWT in 1987.

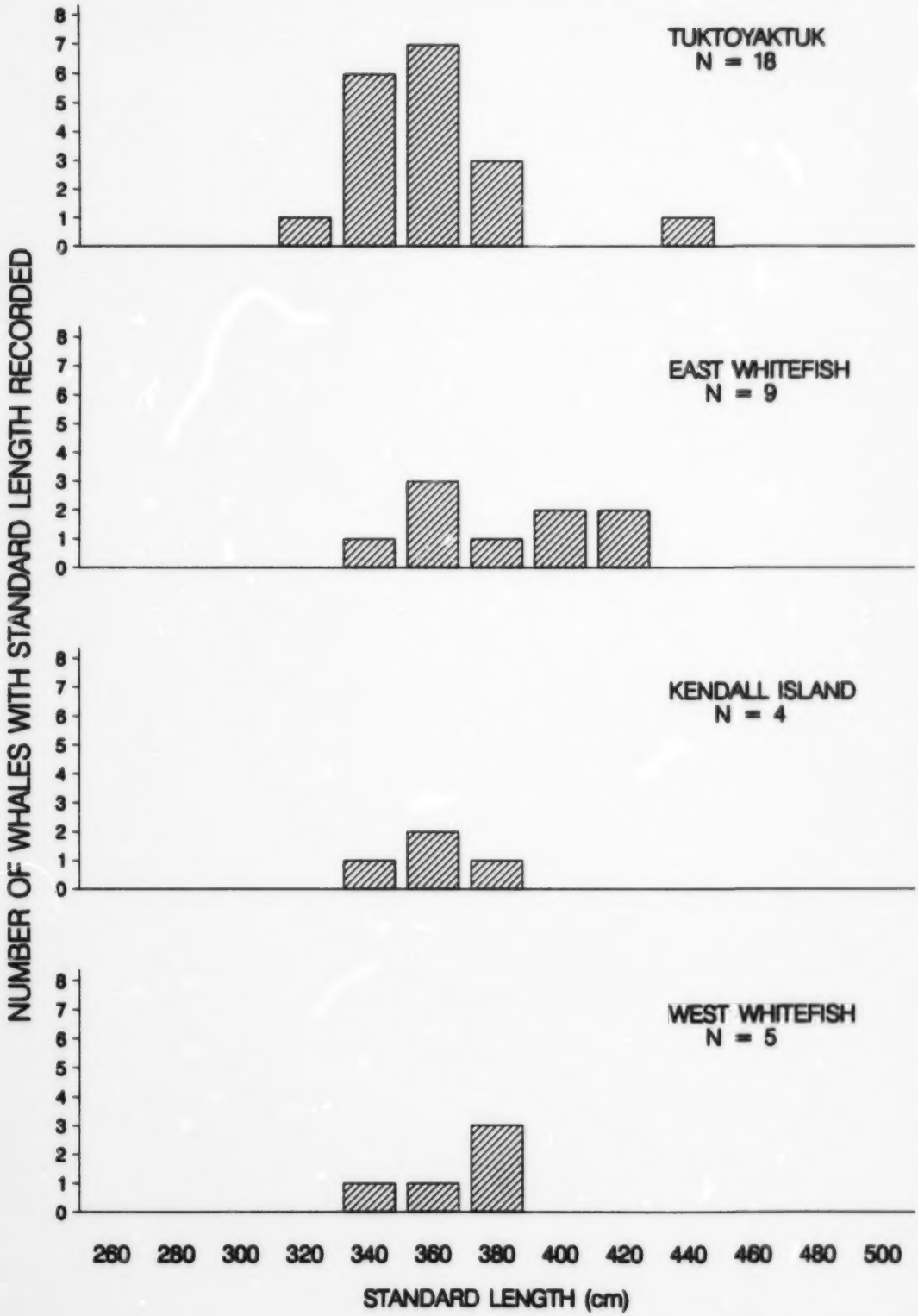

Fig. 3. Length frequencies, by reporting area, of female beluga (Delphinapterus leucas) harvested in the Mackenzie River estuary, NWT in 1987.

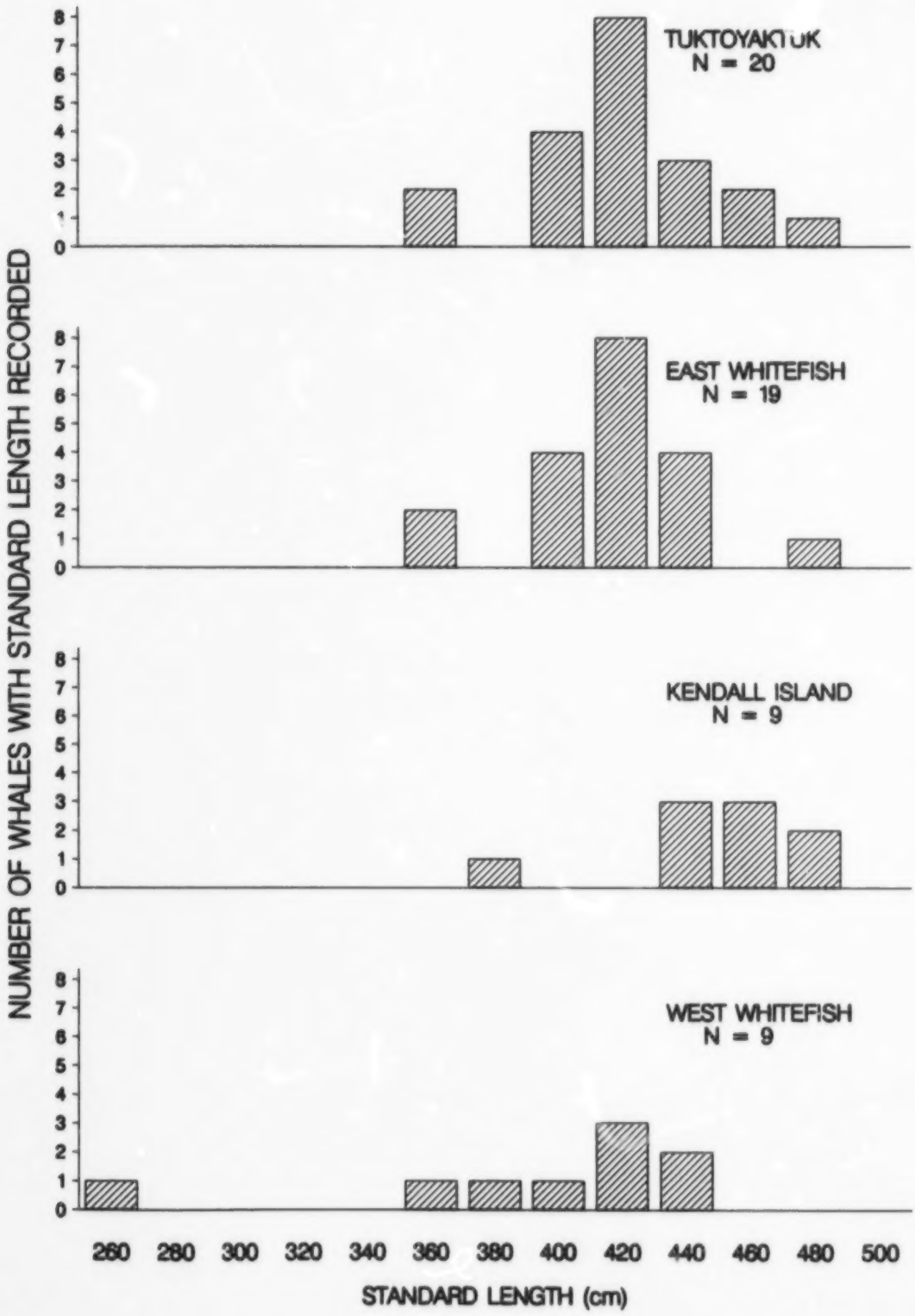
TUKTOYAKTUK
N = 20
EAST WHITEFISH
N = 19
KENDALL ISLAND
N = 9
WEST WHITEFISH
N = 9
NUMBER OF WHALES WITH STANDARD LENGTH RECORDED
0 1 2 3 4 5 6 7 8
260 280 300 320 340 360 380 400 420 440 460 480 500
STANDARD LENGTH (cm)

Fig. 4. Length frequencies, by reporting area, of male beluga (Delphinapterus leucas) harvested in the Mackenzie River estuary, NWT in 1987.

Appendix 1. Data sheet used by hunt monitors to document individual hunts and to collect biological information.

BELUGA WHALE STUDY No: _____

FISH AND MARINE MAMMAL MANAGEMENT DIVISION

AREA: _____ DATE: _____

FIELD WORKER/MONITOR: _____

A. THE HUNT:

WEATHER: _____ SUNNY _____ CLOUDY _____ WINDY _____ RAIN

WATER: _____ RIPPLES (1-6 INCHES) _____ ROUGH (1-2 FEET)

_____ SMALL WAVES (1/2-1 FOOT) _____ STORM (OVER 2 FEET)

HUNTER NAME(S): _____

_____ COMMUNITY _____

HOURS SPENT HUNTING: _____ DID YOU SEE WHALES? YES ____ NO ____

HOW MANY WHALES STRUCK _____ LANDED _____

CALIBRE OF RIFLES AND NUMBERS OF SHOTS FIRED _____

NUMBER OF SHOTS PER LANDED WHALE _____

IF OTHER WHALES LANDED ON THIS HUNT, SAMPLE NUMBERS ARE: _____

_____

B. SAMPLE INFORMATION:

SEX: _____ MALE _____ FEMALE

TOTAL LENGTH: ____ FT ____ IN

COLOR:

_____ BROWN _____ GREY OR BLUISH

_____ WHITE WITH GREY ON FLUKE AND FLIPPERS

_____ WHITE _____ YELLOW

GIRTH: ____ FT ____ IN FLIPPER LENGTH: ____ FT ____ IN

FLUKE WIDTH: ____ FT ____ IN FLIPPER WIDTH: ____ FT ____ IN

IF FEMALE: WAS SHE WITH A NEWBORN (BROWN) CALF? _____ YES _____ NO

WAS SHE GIVING MILK? _____ YES _____ NO

WAS SHE PREGNANT? _____ YES _____ NO

IF PREGNANT, MEASURE LENGTH OF FETUS (UNBORN CALF)

_____ FEET _____ INCHES

IF FETUS IS LARGE, READY TO BE BORN, PLEASE GIVE IT A SAMPLE NUMBER OF ITS OWN AND SAMPLE IT WITH ITS OWN DATA SHEET NO. _____

C. SAMPLES TAKEN:

_____ COMPLETE LOWER JAW

NOTE: PLEASE ENSURE THAT THE SAMPLE NUMBER ON THE SPECIMEN TAG IS THE SAME NUMBER AS SHOWN ON THE TOP RIGHT OF THIS PAGE.